Breaking the Rules: Do Infants Have a True Understanding of False Beliefs?

Jessica Yott

A Thesis

in

The Department

of

Psychology

Presented in Partial Fulfillment of the Requirements
for the Degree of Master of Arts (Psychology) at
Concordia University
Montreal, Quebec, Canada

July 2011

CONCORDIA UNIVERSITY

School of Graduate Studies

This is to certify that the thesis prepared

By: Jessica Yott

Entitled: Breaking the Rules: Do Infants Have a True Understanding of False Beliefs?

And submitted in partial fulfillment of the requirements for the degree of

Master of Arts (Psychology)

Complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the final examining committee:

___Dr. Andrew Chapman________ Chair

___Dr. Dale Stack______________ Examiner

___Dr. Krista Byers-Heinlein _____ Examiner

___Dr. Diane Poulin-Dubois__ _ __ Supervisor

Approved by ____
Chair of Department or Graduate Program Director

___________20___ ____
Dean of Faculty

ABSTRACT

Breaking the Rules: Do Infants Have a True Understanding of False Beliefs?

Jessica Yott

It has been suggested that infants' performance on the false belief task can be explained by the use of behavioural rules. To test this hypothesis, 18-month-old infants were trained to learn the rule that an object that disappeared from location A could be found in location B. Infants were then administered a false belief task based on the violation of expectation paradigm, an intention understanding task, and a modified detour retrieval task. Results revealed that infants looked significantly longer at the display when the experimenter looked for the toy in the full box (box with the toy) compared to infants who observed the experimenter search in the empty box (box without the toy). Results also revealed significant correlations between infants' looking time at the display, score on the intention task, and score on the detour retrieval task. Taken together, these findings suggest that infants possess an implicit understanding of false belief. In addition, they challenge the view that success in the implicit false belief task does not require executive functioning abilities.

Acknowledgements

This research was supported by a grant awarded by the Social Sciences and Humanities Research Council of Canada to Dr. Diane Poulin-Dubois. I would like to acknowledge the Régie Régionale de la Santé et des Services Sociaux de la Région de Montréal-Centre for providing access to birth lists which were used to recruit participants for this study.

First and foremost I would like to thank my supervisor, Dr. Diane Poulin-Dubois, for her support and guidance throughout this project. In addition, I would like to acknowledge the encouragement, patience and understanding of all past and present members of the Cognitive Development laboratory, many of whom have become close friends. A special thank you goes to Melissa Dimitriadis, Alexandra Polonia, and Katherine Gittins for their assistance in data collection and coding.

I have been incredibly fortunate to have an extraordinary family who has supported me every step of the way. I would like to thank my mom for inspiring and encouraging me, but most of all for her unconditional love and support. Similarly, I would like to thank my friends for their positive encouragement. Last, but certainly not least, I would like to thank Tony for his unconditional support and unwavering patience. Without all you, this work would not have been possible. Thank you.

Table of Contents

List of Figures

List of Tables

Breaking the Rules: Do Infants Have a True Understanding of False Beliefs?

The ability to attribute mental states to others and at the same time understand that others may have beliefs, emotions, and desires that differ from one's own is called a theory of mind (ToM; Poulin-Dubois, Brooker, & Chow, 2009; Wellman, 2010). One of the most important milestones in the development of a theory of mind is the understanding of false beliefs. There is currently much controversy about the age at which children develop an understanding of others' false beliefs. Traditionally, it was believed that children first understand false beliefs around 4-5 years of age when they pass verbal standard false belief tasks, such as the change of location and change of contents tests (see Wellman, Cross & Watson, 2001). To attribute a false belief to someone, one must be capable of differentiating false and true propositions and realize that a person falsely believes that something is true, which requires a representational ToM (Perner, Leekam, & Wimmer, 1987). A representational ToM is the understanding that mental states, such as beliefs, are representations of reality as opposed to direct reflections of reality. Therefore, the representation can be an accurate reflection of reality or an inaccurate one. Younger children make the classic false belief error of predicting that, for example, a story character will look for a toy where it now is hidden (after it was moved during her absence) instead of where the character originally saw it hidden. In this case, children do not appear to understand that the story character in fact, has a representation of reality that is inaccurate.

There are two main explanations for why children younger than 4 years of age might consistently fail false belief tests. One refers to a conceptual limitation which posits that young children do not understand that other people can have beliefs that do not match with reality as they themselves know it. Another explanation is that, at least by a certain age, children do have this understanding but that there is something about the traditional false belief tests that lead them to give an incorrect response. More specifically, it is believed that children's failure is due to the strong demands that these tests place on children's other cognitive skills, such as language competence and executive functioning (Bloom & German, 2000; Carlson, Molson, & Hix, 1998; Carlson & Moses, 2001). Executive function includes the ability to exhibit goal directed thought and behaviour (Zelazo, Craik, & Booth, 2004). Individuals must be able to hold in mind the purpose of their behaviour in order to carry it out. In attempting to execute the behaviour, individuals must selectively block out distracting variables. Such actions may be difficult for young children which may explain why they consistently fail the standard verbal false belief task. For example, the correct answer in this task requires young children to inhibit from their response what they know (toy's new location) from what the story's protagonist knows. This inhibitory control requires executive functioning abilities that young children may not yet have fully developed.

By using different kinds of tasks assumed to test belief understanding with minimal cognitive demands, a number of studies have demonstrated an earlier emergence of belief understanding. In one of these tests, based on anticipatory looking, children were presented with a change of location task, in which an object was moved from one box to another during a story's protagonist's absence. However, in addition to the standard action anticipation question, the location at which children looked in anticipation of the protagonist's return was measured. Children as young as 35 months of age showed correct anticipatory looking behaviour. That is, children anticipated that the protagonist would act in accordance with his/her false belief in response to the verbal prompt, “I wonder where the actor will look for the object” (Clements & Perner, 1994; Garnham & Ruffman, 2001). Recently, a completely non-verbal anticipatory looking paradigm was successfully used to replicate and extend these results to a group of 25-month-olds (Southgate, Senju, & Csibra, 2007). Similar results have been shown with 18-month-old infants, providing further evidence for some form of false belief understanding in infancy (Neumann, Thoermer, & Sodian, 2008).

More controversially, several recent studies based on the violation of expectation (VOE) paradigm have claimed that infants, some as young as 7 months of age can attribute false beliefs to others (Kovacs, Teglas, & Endress, 2010; Onishi & Baillargeon, 2005; Surian, Caldi & Sperber, 2007). In the first experiment to test false belief understanding in infancy, Onishi and Baillargeon, (2005) demonstrated that 15-month-olds expect an agent’s search behaviour to be guided by her true or false belief about a toy’s hidden location. More specifically, they familiarized 15-month-old infants to an event that involved an agent hiding a toy in box A. Next, infants observed the agent witness (true-belief condition) or not witness (false-belief condition) a change in the toy’s location from box A to box B. During the test trial, infants watched as the agent reached for the object in the full box (box B) or in the empty box (box A). Interestingly, infants in the true belief condition looked significantly longer when the agent searched in the empty box compared to the full box, indicating that they were surprised by the agent’s behaviour. Conversely, infants in the false belief condition looked significantly longer when the agent searched in the full box compared to the empty box. These findings suggest that infants took into account whether or not the agent witnessed the object transfer. According to the authors, the infants expected the agent to behave according to where she believed the toy to be hidden, and not where the toy was actually hidden.

Subsequent investigations based on the VOE paradigm confirmed and extended the results of Onishi and Baillargeon (2005). Surian and colleagues (2007) demonstrated that 13-month-olds expected a computer-animated caterpillar's behaviour to vary according to the information it received about an object's location. Moreover, Kovacs and colleagues (2010), demonstrated that infants as young as 7 months of age attributed false beliefs to cartoon characters. Träuble, Marinović and Pauen (2010) replicated and extended these results by demonstrating that 15-month-olds can not only take into account an agent's visual information access (whether or not the agent observed the object transfer), but also manual information access. In this study, infants observed an agent manually transfer an object from box A to box B with their hands however, the agent was facing backwards during the transfer. That is, the agent manually transferred the object with his/her hands behind his/her back and therefore could not see the object move from one box to the other. In this study, infants expected the agent to search for the object in the correct location despite the fact that the agent did not observe the object transfer. Furthermore, Song, Onishi, Baillargeon and Fisher (2008) showed that 18-month-olds understand that an agent's false belief about the location of an object can be corrected by an appropriate communication. Infants of the same age can also attribute to an agent a false belief about the identity of an object (Scott & Baillargeon, 2009). Finally, Buttelmann, Carpenter and Tomasello (2009) used a more active behavioural response, helping, to demonstrate that 18-month-old infants take into account an actor's beliefs before actively helping him/her attain his/her goal.

Taken together, the results of these studies have led some researchers to conclude that infants in the second year of life can already attribute false beliefs to others (Baillargeon, Scott, & He, 2010). According to this rich interpretation, tasks based on spontaneous (as opposed to elicited) responses do not require response-selection and response-inhibition processes that overwhelm young children's limited cognitive resources. These tasks only require the infant to access a representation of the agent's false belief. Despite the mounting evidence in favour of a rich interpretation of infants' behaviours in false belief-inducing situations, this account has generated a lively debate. Several "leaner" alternative interpretations for these findings, all involving lower-level processes, have been proposed (Perner, 2010; Sirois & Jackson, 2007). For example, some researchers have argued that in tasks based on the VOE paradigm, looking times may be explained by infants noticing that something is unusual (Haith, 1998; Perner & Ruffman, 2005; Ruffman & Perner, 2005). The longer looking times demonstrated by infants when the agent searches in the box to which the toy has been moved could be based on a learned behavioural rule. More specifically, infants may predict others' behaviours based on simple behavioural rules such as, people will look for an object in the last place that they saw it or a triple association between the actor, the toy and location of the box (Perner & Ruffman, 2005; Ruffman & Perner, 2005). While the "rich" mentalistic account of infants' performance on the false belief task suggests that infants understand others' mental states, the "lean" behavioural interpretation suggests that infants make predictions about people's behaviour based on learned rules (Perner, 2010). Morgan's (1903) recommendation to choose the most parsimonious explanation supported by the data, suggests that if a simpler, learning account can explain the data, then there is no need to invoke a more complex explanation (Stevens, 2010). Unfortunately, designing a study to test these theories against one another has proven to be difficult as a behavioural rule can be used to explain almost any interpretation based on ToM understanding. Despite this difficulty, Perner (2010) suggests that designing such a test is possible.

The main objective of the present experiment was to determine whether the results from the non-verbal false belief task could be explained by the activation of simple behavioural rules. More specifically, the current experiment was designed to determine if infants would expect an agent to search for an object in the location she falsely believes it to be hidden, even when they have learned to expect that objects are never at the last place they saw them. To do this, infants were first trained to search for a toy in location B after they had observed it placed in location A. They were then administered the non-verbal false belief task originally designed by Onishi and Baillargeon (2005). It was hypothesized that if infants' performance on the false belief task is based on the use of behavioural rules, than infants would expect an agent to search for the object in the full box and look longer when she searched in the empty box (box with no object). In other words, it was expected that the looking time pattern observed in the traditional false belief task would be reversed and match those from a true belief condition. This would indicate that infants predicted that the agent's actions should be based on the newly acquired rule that objects are not in the last observed location.

A second objective of the current experiment was to examine the relationship between false belief understanding and other theory of mind abilities in infancy. If infants have a psychological reasoning system that provides them with a causal framework for interpreting the actions of agents, then one would expect performance on the implicit false belief tasks to be related to performance on other ToM tasks, as is the case when older children are tested with explicit false belief tasks (Carlson, Mandell, & Williams, 2004; Hughes & Esnor, 2007). Although there have been a multitude of studies examining false belief understanding in infancy using the VOE paradigm, none have examined the relationship between infants' performance on this task and other ToM abilities, such as intentions. Given that previous research demonstrates that intention understanding develops in the second year of life, it seems reasonable to expect that this ability is necessary and therefore associated with false belief understanding at 18-months of age (Behne, Carpenter, Call, & Tomasello 2005; Bellagamba, Camaioni, & Collonessi, 2006; Bellagamba & Tomasello, 1999; Carpenter, Akhtar, & Tomasello, 1998; Meltzoff, 1995; Olineck & Poulin-Dubois, 2009). If infants understand others' false beliefs, then one would expect that they would also understand others' intentions. Early understanding of intentions was measured with the behavioural re-enactment task (Meltzoff, 1995) and compared with performance on the implicit false belief task.

A final objective of the current experiment was to examine the link between performance in a false-belief inducing task and executive functioning. If implicit false belief reasoning in the VOE or anticipatory looking procedures does not require a response-inhibition process (unlike tasks based on elicited response), then one would not expect a relation between executive functioning and ToM in infancy. Infants' inhibitory control abilities were tested using a modified version of the Detour retrieval task.

Method

Participants

A group of forty-eight infants participated in the study (21 males, 27 females). Infants' mean age was 18.76 months (*SD* = .57, *range* = 16.82 to 18.47). On the basis of parental reports, infants had no visual or auditory impairments and had a minimum 35-week gestational period. All infants were recruited (see Appendix A for recruitment letter) from birth records provided by a governmental health services agency.

An additional twenty-two infants participated but were excluded from the study due to fussiness (*n* = 10), experimenter error (*n* = 7), parental interference (*n* = 3), and technical difficulties (*n* = 2).

Materials

Training task. The materials included three containers (10 cm diameter, 11 cm height) of various colors (orange, yellow, blue) with loose fitting lids. In addition, ten small toys were used (blue block, pink block, red ladybug, monkey, bird, seal, fish, duck, flower). A white bristol board (75 cm width, 50 cm height) and stand to hold the board were also used.

False belief task. A puppet theatre (110 cm width, 97 cm length, 116 cm height) was used to display the experimenter hiding and searching for a cup through a window (44.5 cm width, 77.5 cm length), approximately 59.7 cm from the bottom of the stage floor (see Appendix B for stimuli). Infants observed the experimenter from a child seat placed 90 cm from the display. The window was covered by a white curtain that was operated by the experimenter and used to hide the objects on the puppet theatre's ledge (17.8 cm width, 110 cm length). A red cup (7.5 cm diameter, 10.5 cm height) covered in colourful stickers was placed in the ledge directly between a yellow and green box (14 cm width, 14 cm length, 14 cm height). The distance between the boxes was 18 cm. Each box had an opening on the side facing the cup (14 cm width, 14 cm height) that was covered with a fabric fringe. A rectangular opening underneath each box allowed for the attraction between a magnet located inside the cup (2.5 cm width, 5 cm length, 0.6 cm height) and a magnet operated by the experimenter (7.6 cm diameter). The magnet was used to transfer the cup from one box to the other underneath the ledge without infants observing the experimenter doing so. Infants' looking patterns were coded live by a second experimenter using the Habit 2000© program (University of Texas) on a Mac G4 computer.

Detour retrieval task. The materials (Appendix C) for this task consisted of a red wooden box (27.5 cm width, 25.5 cm height, 37 cm depth) and four small toys (duck, dog, boat, fire truck). On the front side of the box (27.5 cm width, 25.5 cm height) there was a centered rectangular hole (16 cm width, 13 cm height). A transparent window made of plexiglass covered the opening. The window allowed children to see, but not directly retrieve, a toy from inside the box. The window was attached on the inside of the box by two hinges and could only be opened and closed via remote control. A colourful knob (8 cm length, 6.5 cm height) was placed on the left hand side of the box. The toys ranged in size from 8 cm by 6 cm to 12 cm by 6 cm. They all fit inside the box and could comfortably fit through the rectangular opening. A small push light located on the roof of the box illuminated its contents making it easier for children to see the toys.

Behavioural re-enactment task. The materials (Appendix D) used for this task closely resembled those used by Meltzoff (1995), Bellagamba and colleagues (2006) and Olineck and Poulin-Dubois (2009). The materials consisted of five novel object pairs. Each pair of objects could be used to complete an intended target action. The first object pair was a blue dumbbell that could be separated at the middle into two pieces. The dumbbell consisted of two 4 cm wooden cubes that were each attached to a 8 cm long plastic cylinder. The second object pair was a box (15 cm width, 15 cm height, 5 cm depth) with a recessed button (3 cm length, 2 cm width) that could be activated by a plastic wand (17.5 cm length). The box was supported by a base that tilted 30 degrees off the table so that the button faced the infant. The third object pair was a loop (7.5 cm diameter) that could be hung on a horizontally protruding prong. The prong was 16 cm in height, protruded 11 cm towards the child and had a bulbous end. The fourth object pair consisted of a cup (10 cm height, 7.5 cm opening) and a string of colourful beads (25 cm long). The fifth object pair consisted of a wooden dowel (2 cm height, 1.4 cm diameter) and a transparent plastic square (10 cm) with a hole (2 cm diameter) cut out of the middle. The dowel was mounted on a square wooden base (10 cm).

Design and Procedure

Infants and their parents were invited to the laboratory for a testing session that lasted approximately 45 minutes. Upon arriving they were first brought to a reception room where infants were familiarized with the experimenters and the environment while parents completed a consent form (Appendix E) and demographic questionnaire (Appendix F). Tasks were recorded using two cameras and recordings were used to code infants' responses off-line. All families were provided with a $20 financial compensation for their participation in this study.

Training task. Infants were placed in a high chair in front of a large table, while the experimenter sat across from them. The aim of this task was to teach infants the rule that objects are never in the last place they were seen. The experimenter first administered a warm-up trial. She placed the yellow container on the table and a small toy (ladybug) to its right. The experimenter then said “Hi (child’s name). Watch me hide the toy” as she removed the lid of the container, placed the toy inside and put the lid back on the container. The experimenter then picked up the container and shook it before she placed it in front of the child and said “Can you find the toy? Where’s the toy?”. If infants were unable to retrieve the toy from inside the container during the first warm-up a trial, a second warm-up trial was administered. Once infants successfully retrieved the toy from the container, the administration of the four training trials began. For these trials, the experimenter placed a small toy in front of her, the orange container to its right and the blue container to its left. To the far right side, the experimenter placed a white bristol board on a black stand, so that the board was standing upright and could act as a barrier between the infants and the containers. To begin, the experimenter said “Hi (Child’s name), Watch me hide the toy” as she picked up the toy and placed it inside the blue container. She then placed the lid back on the container, pulled the white barrier in front of the containers so that the child could not see her switch the toy from the blue to the orange container. The experimenter then pushed the barrier back to the right hand side and said “Can you find the toy? Where’s the toy?” as she slid the containers across the table and placed them in front of the child. Once the infant successfully retrieved the toy, the trial ended. Following the four training trials, a teaching trial was administered. The teaching trial followed the same procedure as the training trials, except that before placing the containers in front of the infant the experimenter said “Where is the toy?”. The experimenter then opened the blue container and said “No. The toy is not in here” as she shook her head from left to right. She then tilted the container towards the child so he/she could see that the container was in fact empty. The experimenter then opened the orange container and said “Yes. The toy is in here” as she nodded her head. She then tilted the container towards the child so he/she could see that the toy was in fact inside the orange container. The experimenter then placed both containers in front of the child and said “Can you find the toy? Where’s the toy?”. Following the teaching trial, four more training trials were administered. If the infant was unable to retrieve the toy from inside of the container within 15 s, the experimenter prompted the infant by saying “Where is the toy?”. If after another 15 s the infant was still unable to open the container, the experimenter removed the lid of the container and showed him/her the location of the toy. Finally, the location of the toy was counterbalanced across infants. That is, approximately half of the infants observed the toy move from the blue to the orange container, and approximately half of the infants observed the toy move from the orange to the blue container.

Since the goal of this task was to teach infants a new rule, the task was ended once infants searched for the toys in the correct location (first attempt) on two consecutive trials, as it implied that infants had learned the new rule. This criterion did not include the first trial, as a correct search on the first trial could only be due to chance. Finally, if infants successfully searched for the toy on the fourth trial, the teaching trial was skipped to allow infants to meet this criterion on the fifth trial. If infants did not successfully search for the toy on the fifth trial, then the teaching trial was administered, followed by 3 more training trials. If infants searched for the toy in the correct container on the last trial, one more trial was administered to allow them to reach the learning criteria.

False belief task. The false belief task was adapted from the one designed by Onishi and Baillargeon (2005) to examine infants' understanding of false beliefs. This task is non-verbal and based on the VOE paradigm. The experimenter who administered this task was not the same experimenter who administered the training task. This was to ensure that if the training task influenced infants' behaviour on the false belief task, the effect would not be specific to the experimenter with whom they interacted during the training task. During this task, the experimenter wore a white t-shirt and a white visor which prevented infants from trying to establish eye contact. All infants completed three familiarization trials, one belief induction trial, and one test trial. Prior to the first familiarization trial, the experimenter raised the curtain and said "Hello (Child's name)" as she put on the white visor and then closed the curtain. At the start of the first familiarization trial, the experimenter raised the curtain, picked up the cup and played with it for a few seconds before hiding it inside one of the two boxes. Each trial lasted 8 s. Once the cup was hidden, the experimenter paused with her hand inside the box until the trial ended. These trials were coded live and coding began once the experimenter finished the demonstration and paused. A trial ended when the infant stared at the paused display for a maximum duration of 30 s or if the infant looked away from the display for more than two consecutive seconds. In addition, a trial was ended only when an infant had looked at the display for a minimum of two cumulative seconds. The curtain was controlled by the experimenter and lowered in between trials. During the second and third familiarization trials, the experimenter reached into the box where the cup was hidden. Then, she paused with her hand inside the box until the trial ended.

During the belief induction trial, the experimenter was out of sight and discretely moved the cup along the ledge from one box to the other by means of a magnet that was placed underneath the ledge directly underneath the cup. In this way, the cup appeared to move on its own from one box to the other. Next, the infants received a test trial during which the experimenter reached into one of the two boxes. As a result, the experimenter searched for the cup either in the correct (Full Box condition) or incorrect (Empty Box condition) location. Half of the children were randomly assigned to each of these two conditions (Full Box condition: n = 25; Empty Box condition: n = 23). The box in which the experimenter searched, and the direction in which the cup was moved were counterbalanced across participants. Furthermore, if during the training task the toy moved from left to right, then the cup moved from right to left in the false belief task. This was done to ensure that if infants' newly acquired rule were to influence their performance on the false belief task, a location effect could be ruled out.

A video camera positioned behind the back wall of the puppet theatre recorded the infants' faces. These recordings were later used to code infants' looking patterns during each trial off-line. Infants' looking patterns were also coded live by a second experimenter who was hidden from the child's view.

Detour retrieval task. The procedure used for the detour retrieval task was adapted from McGuigan and Nunez (2006) to measure toddlers' executive functioning. Infants were placed in a high chair in front of a large table, while one parent sat directly behind them. The experimenter sat on the right-hand side of the child with the box placed directly in front of her, but angled towards the infant. The task consisted of a demonstration phase followed by a test phase. In the demonstration phase, the experimenter said “Hi (Child’s name). Watch me get the toy” and modeled the correct sequence of actions in order to retrieve the toy from inside the box. In this case, she turned a knob located on the left-hand side of the box three times, which appeared to open the window. The experimenter controlled the opening and closing of the window via a remote control. Following the demonstration, the experimenter said “Now it’s your turn. You go get the toy” and placed the box directly in front of the child. If the child did not attempt to retrieve the toy following a 15 s period, the experimenter provided a prompt. This process was repeated four times with all four toys.

Behavioural re-enactment task. The procedure used for this task was based on Meltzoff (1995), Bellagamba and colleagues (2006) and Olineck and Poulin-Dubois (2009). More specifically, infants were tested on the “Demonstration of Intention” condition of the re-enactment task (Meltzoff, 1995). The task consisted of five test trials, each with a novel object pair. The experimenter sat across from the child and presented the object pair and said “Hi (Child’s name). Watch, I have something to show you”. The experimenter then modeled the intention to perform an action three times. Importantly, the experimenter did not provide verbal or facial expressions during the demonstrations. For the dumbbell object, the experimenter held a wooden cube in each hand and appeared as though she was trying to pull it apart into two halves. The experimenter failed to do so, however, because one of her hands would slip off the end as she tried to pull. The hand that slipped off the end alternated between left and right for the three demonstrations. For the box with the button, the experimenter placed the box on the table so that the button was facing the infant. She then tried to push the button with the wand but missed all three times. For each attempt she lifted the wand and slowly moved it toward the button but missed it by hitting slightly above, below, and to the right of the button. For the demonstration with the horizontal prong and loop object pair, the experimenter placed the prong device on her left hand side but still facing her. This was done so that the infant could get a clear view of the demonstration. The experimenter picked up the loop and attempted to hang it on the prong, but "accidently" missed all three times. For the cup and beads trial, the experimenter placed the cup in front of her on the table and the beads just next to it. She then picked up the beads and attempted to place them inside the cup, but missed all three times. For the demonstration with the plastic square and wooden dowel, the experimenter first placed the objects on the table in front of her. She then picked up the plastic square, and using both hands, attempted to place the square onto the dowel, but missed all three times. After the demonstrations for each novel object pair, the experimenter offered the objects to the child and said "Now it's your turn". Infants were given 20 s to manipulate the objects before the next pair of objects was introduced. Presentation of the object pairs was counterbalanced across infants.

Coding and Reliability

Training task. Each participant was coded by the primary investigator (see Appendix G for an example of the coding sheet used for this task). As previously mentioned, the task ended once the infant searched for the toy in the correct container on two consecutive trials. Therefore, the experimenter coded how many trials it took for the infant to reach this criterion. To establish inter-coder reliability, 25% of the sample was coded by a second independent observer. There was 100% agreement between the two independent coders.

False belief task. Recordings from this task were later coded by the primary investigator who calculated looking time at the target box (examined box), non-target box (unexamined box), the experimenter, as well as total looking time at the display (see Appendix H for an example of the coding sheet used for this task). In order to assess inter-coder reliability, a second independent observer coded a random selection of 25% of all videotaped sessions of the false belief task. An equal number of participants were selected from both conditions (Full box, Empty box) as well as for both orders (left to right, right to left). Using Pearson product-moment correlations, the mean inter-observer reliability for the looking time at the target box and the non-target box during the test trial was r = .94 and r = .93, respectively. The mean inter-observer reliability for the looking time at the experimenter during the test trial was r = .99. Finally, the mean inter-observer reliability for the overall looking time at the display during the test trial was r = .99 indicating high agreement.

Detour retrieval task. The coding scheme used for this task was modeled after McGuigan and Nunez (2006). For each of the four test trials, the experimenter coded whether or not infants used the knob to open the window and retrieve the toy from inside the box (see Appendix I for an example of the coding sheet used for this task). The experimenter coded infants' first touch (window vs. knob). If infants made contact with the knob before they made contact with the window they were awarded one point for each of the four trials. To establish inter-coder reliability, 25% of the sample was coded by a second independent observer. There was 100% agreement between the two independent coders.

Behavioural re-enactment task. The coding scheme used for this task was modeled after Meltzoff (1995) and Bellagamba and colleagues (2006). For each test trial infants were given a 20 s period to respond, which began with his/her first touch to the object. The experimenter coded whether or not the child completed the target action within this time frame (see Appendix J for an example of the coding sheet used for this task). The total score could range from 0 to 5. Infants were awarded one point if they: 1) pulled the dumbbell apart, 2) pushed the button with the wand, 3) hung the loop on the protruding prong, 4) placed more than half of the string of beads inside the cup, and 5) were able to place the square over the dowel so that the dowel protruded through the plastic square. To establish inter-coder reliability, 25% of the sample was coded by a second independent observer. There was 100% agreement between the coders.

Results

In the training task, the mean number of trials administered was $M = 6.85$ ($SD = 2.58$, $range = 3.00 – 11.00$). Thirty-four infants (70.8 %) met the learning criterion of two consecutive successful searches (first attempt) in this task. The mean number of training trials administered to the subsample of rule learners was $M = 5.85$ ($SD = 2.40$, $range = 3.00 – 11.00$). As the main objective of the current study was to test if learning a new rule would influence performance on the false belief task, all further analyses were conducted with this subsample ($n = 34$). Of these infants, 18 were included in the Full Box condition and 16 were included in the Empty Box condition.

Infants' looking times at the target box, the non-target box, the experimenter, and total looking time at the display during the test trial were calculated. In order to compare infants' looking times in the Full Box condition to those in the Empty Box condition an independent t-test was conducted comparing total looking time at the display. Results revealed that infants in the Full Box condition looked significantly longer at the display (M = 11.44 s, SD = 5.50) compared to infants in the Empty Box condition (M = 7.22 s, SD = 3.73, $t(32) = 2.58$, $p < .05$, $d = .90$). A second independent samples t-test was conducted to compare looking times at the experimenter between the Full Box and Empty Box condition. Similarly, results revealed that infants in the Full Box condition looked significantly longer at the experimenter during the test trial (M = 8.36 s, SD = 4.61) compared to infants in the Empty Box condition (M = 5.07 s, SD = 3.34, $t(32) = 2.35$, $p < .05$, $d = .82$). To ensure that infants in both the Full and Empty box condition were equally attentive during the belief induction trial during which the cup changed location, an independent samples t-test was conducted to compare infants' total looking times. Results revealed that infants in both groups looked equally long at the display during this trial (Full Box condition: M = 9.59 s, SD = 7.15; Empty Box condition: M = 9.35 s, SD = 7.57), $t(32) = .097$, $p = .92$, $d = 0.03$. Similarly, to determine if infants in the Full and Empty Box conditions were attentive to the box in which the experimenter was searching during the test trial, an ANOVA was conducted with condition (Full Box, Empty Box) as a between-subjects factor, and search location (target, non-target) as a repeated measure. Results from this analysis revealed a significant interaction between condition and search location, $F\,(1,32) = 7.60$, $p < .01$, $\eta p^2 = 0.19$ (See Figure 1). Pairwise posthoc comparisons revealed that infants in the Full Box condition looked significantly longer at the target box (M = 2.52 s, SD = 0.38) than at the non-target box (M = 0.56 s, SD = 0.20), $p < .001$. Conversely, infants in the Empty Box condition looked equally long at the target box (M = 1.31 s, SD = 0.84) and at the non-target box (M = .84 s, SD = .22), $p = .23$.

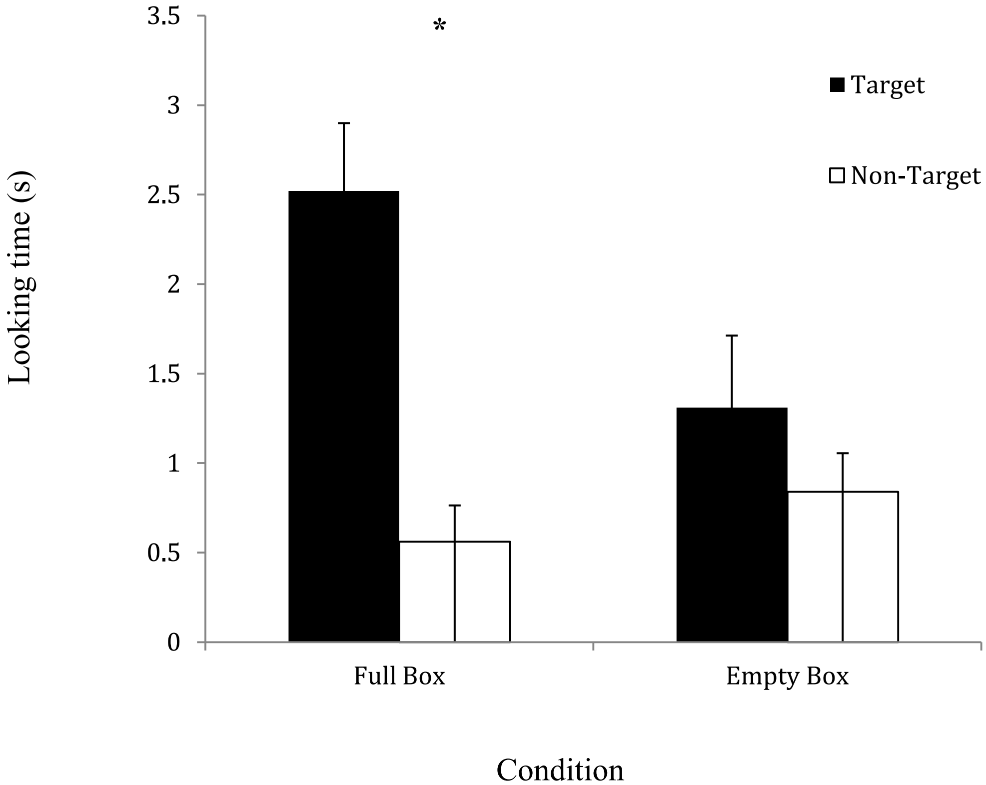


Figure 1. Mean looking time (s) at the target and non-target box in the full box and empty box conditions. Standard errors are represented in the figure by the error bars attached to each column.

To examine the relations between false belief, intention understanding, and executive functioning, infants' looking times in the false belief task were correlated with scores on the behavioural re-enactment, detour retrieval and training task. All infants were included in the following analysis regardless of whether or not they had learned the rule in the training task, as the rule learning did not influence infants' performance on the VOE false belief task. To ensure that the looking pattern remained the same when all infants were included in the false belief task, a second independent t-test was conducted comparing total looking time at the display (Full Box condition $n = 25$; Empty Box condition $n = 23$). As expected, results revealed that infants in the Full Box condition looked significantly longer at the display ($M = 10.18$ s, $SD = 5.42$) compared to infants in the Empty Box condition ($M = 6.59$ s, $SD = 3.34$, $t(40.38) = -2.79$, $p = .01$, $d = .80$). To ensure that infants in both the Full and Empty box condition were equally attentive during the belief induction trial during which the cup changed location, an independent samples t-test was conducted to compare infants' total looking times. Results revealed that infants in both groups looked equally long at the display during this trial (Full Box condition: $M = 9.19$ s, $SD = 6.38$; Empty Box condition: $M = 9.57$ s, $SD = 6.58$), $t(46) = .204$, $p = .84$, $d = .06$).

Infants' average performance on the behavioural re-enactment task, the intention task and the training task are presented in Table 1. As infants' performance on the false belief task differed according to condition, looking times were correlated with age and scores on the intention, detour retrieval and training task separately. Results from these analyses are presented in Table 2. Pearson product-moment correlations revealed a significant positive correlation between total looking time at the display in the false belief

Table 1.

Means and Standard Deviations for the Behavioural Re-enactment, Rule Learning, and Detour Retrieval Tasks

Measure	*M*	*SD*	*Range*	*N*
Behavior Re-enactment Task	2.75	1.25	0-5	61
Rule Learning Task	6.85	2.58	3-11	61
Detour Retrieval Task	2.00	1.49	0-4	47

Table 2.

Correlations among measures of False Belief, Intention, Rule Learning, Executive Functioning and Age.

Measure	1	2	3	4	5	6	7	8
1. Age	-	-.23	-.48*	-.15	-.19	.12	.04	.24
		n = 25	*n* = 25	*n* = 23	*n* = 23	*n* = 61	*n* = 61	*n* = 47
2. False Belief: Total Looking Time (Full Box)		-	.55**	-	-	0.35^{t}	-0.50**	0.51*
			n = 25			*n* = 22	*n* = 25	*n* = 17
3. False Belief: Target box (Full Box)			-	-	-	.39^{t}	-.33	.02
						n = 22	*n* = 25	*n* = 17
4. False Belief: Total Looking Time (Empty Box)				-	.07	0.10	-.04	-.04
					n = 23	*n* = 22	*n* = 23	*n* = 18
5. False Belief: Target box (Empty box)					-	.14	.37^{t}	.44^{t}
						n = 22	*n* = 23	*n* = 18
6. Intention						-	-.17	.26^{t}
							n = 56	*n* = 42
7. Rule Learning								.10
							-	*n* = 45
8. Detour Retrieval								-

Note. * $p < .05$ (two-tailed), ** $p < .01$ (two-tailed), ^{t} trend $p < .10$ (two-tailed).

task (Full Box condition) and infants' score on the detour retrieval task ($r(15) = .51$, $p = .04$). In addition, a significant negative correlation was found between infants' total looking time at the display in the false belief task (Full Box condition) and the number of trials administered in the rule learning task ($r(23) = .-.50$, $p = .01$). Furthermore, results revealed a trend when examining the relation between infants' scores on the intention task and infants' total looking time at the display (Full Box condition; $r(20) = .35$, $p = .10$) and infants' looking time at the target box in the false belief task (Full Box condition; $r\ (20) = .39$, $p = .07$).

As expected, results revealed a significant correlation between total looking time at the display and total looking time at the target box in the false belief task (Full Box condition; $r(23) = .55$, $p = .01$).When examining infants' looking times in the Empty Box condition, correlations revealed a trend between looking time at the target box and infants' scores on the detour retrieval task ($r(16) = .44$, $p = .07$) and infants' scores on the training task ($r(21) = .37$, $p = .08$). Finally, a trend was revealed between infants' performance on the detour retrieval task and the intention task ($r(41) = .253$, $p = .09$) regardless of their status (Empty or Full Box condition) in the false belief task (n =43).

As age was found to be significantly correlated with looking times in the false belief task ($r(23) = -.48$, $p = .02$), Pearson partial correlations were conducted in order to control for the relation between age and the variables of interest. These correlations are presented in Table 3. All significant correlations remained once age was controlled for. Additionally, results revealed a significant correlation between infants' total looking time at the display in the false belief task (Full Box condition) and the intention task ($r(19) = .44$, $p = .05$). Similarly, results revealed a significant correlation between infants' total

Table 3.

Correlations among measures of False Belief, Intention, Rule Learning and Executive Functioning Controlling for Age

Measure	1	2	3	4	5	6	7
1. False Belief: Total Looking Time (Full Box)	-	.55*	-	-	0.44*	-0.49**	0.57*
		n = 25			*n* = 22	*n* = 25	*n* = 17
2. False Belief: Target box (Full Box)		-	-	-	.61**	-.32	.15
					n = 22	*n* = 25	*n* = 17
3. False Belief: Total Looking Time (Empty Box)			-	.04	0.11	-.001	-.003
				n = 23	*n* = 22	*n* = 23	*n* = 18
4. False Belief: Target box (Empty box)				-	.16	.44*	.50*
					n = 22	*n* = 23	*n* = 18
5. Intention					-	-.22	.26
						n = 56	*n* = 42
6. Rule Learning							.12
						-	*n* = 45
7. Detour Retrieval							-

Note. * $p < .05$ (two-tailed), ** $p < .01$ (two-tailed), [t] trend $p < .10$ (two-tailed).

looking time at the target box in the false belief task (Full Box condition) and the intention task ($r(19) = .61$, $p = .003$). With regards to looking time at the target box in the false belief task for those infants in the Empty Box condition, partial correlations controlling for age revealed a significant correlation between total looking time at the target box and the training task ($r(20) = .44$, $p = .04$) and the detour retrieval task ($r(20) = .51$, $p = .04$). Finally, controlling for age appeared to remove the relation between the intention task and the detour retrieval task ($r(39) = 26$, $p = .11$).

Discussion

In this study, two main contributions to the research on infants' implicit understanding of false belief are provided. First, the hypothesis that infants' performance on the implicit change of location false belief task is driven by infants' usage of the rule that people search for an object in the last place they saw it, was directly tested. A series of recent studies have demonstrated that infants as young as seven months of age attribute false beliefs to others (Buttelmann, et al., 2009; Kovacs et al., 2010; Neumann, et al., 2008; Southgate et al, 2007; Surian et al., 2007). This rich interpretation has not gone unchallenged. For example, Perner and Ruffman (2005) have proposed alternative explanations for the abovementioned findings. One explanation suggests that these infants do not understand others' beliefs but rather behave according to acquired behavioural rules. The goal of the current study was to test the hypothesis that the results from the false-belief task based on the VOE paradigm can be explained by the activation of simple behavioural rules. Using a rule training paradigm, infants first learned to expect an object *not* to be in the last place it was seen. That is, infants were trained to expect and search for a toy in location B when they had just seen it disappear in location A.

Infants were then administered the non-verbal false belief task. If infants' performance on this task is driven by the behavioural rule that objects are in the last place they were seen, then teaching them that objects are *not* in the last place you saw them should alter the pattern of looking times in the false belief task. More specifically, infants should now expect the experimenter to search for the object in the full box (location where they did *not* last see the object) as opposed to the empty box (where they last saw the object). In other words, the looking patterns typically observed should be reversed.

Results revealed that infants looked longer at the display when the experimenter searched for the object in the full box compared to when she searched in the empty box. This indicates that infants expected the experimenter to search for the object in the empty box and were surprised when she did not. Infants therefore expected that the experimenter would search for the toy in the empty box because she had not seen it change location during the induction trial. These results are consistent with those of Onishi and Baillargeon (2005) and do not support the hypothesis suggesting that infants' performance on the implicit false belief task is due to the activation of behavioural rules. Had this been the case, infants should have been surprised when the experimenter searched in the empty box, because they were expected to generalize their newly acquired behavioural rule, specifically, that objects are not in last observed location, to the experimenter. Instead, there was no indication that infants were relying on a simple behavioural rule during the task. These results seem to support the hypothesis that infants may in fact have an understanding of others' false beliefs.

When examining infants' looking times at the target box (box where the experimenter searched for the toy in the test trial) and non-target box (box that the experimenter did not search), results revealed that infants in the Full Box condition looked significantly longer at the target box than the non- target. These results are not surprising as the box with the toy was also the box in which the experimenter was searching in that condition. Conversely, in the Empty Box condition, infants looked equally long at the target and non-target box. Recall that in this condition, the experimenter was searching for the toy in the empty box, so infants appeared to split their looking time between the box the experimenter was searching in and the box that contained the toy. These results demonstrate that although infants' attention was grabbed by the experimenter's actions, they recalled the toy's actual location and this memory trace directed their attention to the correct box.

No doubt, there are a few possible interpretations for the present findings. First, it is likely that infants' learning of the new rule was not robust enough, as the new rule was only taught over a few trials. Although the analysis only included infants who successfully searched for a toy in the correct location in the training task, the experience acquired might not have been sufficient to override 18 months of experience with objects typically being in the last place they saw them. Results from a recent study using a connectionist model demonstrated that to succeed on an implicit false belief task, one must first override the default assumption of true belief (Berthiaume, Onishi, & Shultz, 2008). Thus, intensive training might be necessary to override the over-learned rule that people find objects where they last saw them (true belief). Another explanation for the observed lack of transfer is that infants could have learned that objects are always in the "blue" container, or objects are always on the "left" side. Thus, even if infants had learned the intended behavioural rule, it is possible that they did not generalize this newly acquired rule to the new context of the false belief task. In addition, it is important to note that during the teaching trial in the training task, the experimenter searched in the last place the object was hidden before searching for the object in its new location. This trial may have confused infants as the experimenter did not act in accordance with the new behavioural rule. Finally, it is important to note that this task took place in a separate room, with a different experimenter, and with different colored containers. Therefore it is possible that infants did not draw upon the new behavioural rule in this new situation. More specifically, infants may have treated the new rule as specific to a particular situation (toy is not in the last place they saw it) as opposed to general knowledge that others would be expected to share with them (objects are in the last place you saw them). The idea that infants distinguish between this two types of knowledge when reasoning about beliefs comes from recent work by Scott, Baillargeon, Song and Leslie (2010) who demonstrated that infants are sensitive to this type of information when reasoning about the properties of objects. Given these limitations, it would be premature to conclude that infants' performance is due to a true understanding of others' false beliefs, as opposed to the activation of behavioural rules.

Future studies should include modifications to the present design in order to maximize the likelihood that infants will transfer a newly acquired behavioural rule to the false-belief task. For example, the same experimenter administering both the training and false belief task would add consistency across tasks and increase the likelihood of infants generalizing the new rule. In addition, the direction of the object location change should be consistent across the training and false-belief tasks. In the current study, infants learned to search for a toy on the right-hand side after having observed it hidden on the left-hand side and then observed the toy on the false belief task move from the left to the right hand side. Although this decision was made to control for any location effects during the false belief task, future studies may consider keeping the change of location consistent (i.e. left to right in both tasks) to increase the opportunity for generalization. Finally, future studies may also consider using the same coloured boxes in the false belief and training tasks.

A second main contribution was to examine the concurrent relationships between infants' performance on the false belief task and other measures of psychological reasoning as well as executive functioning. Although looking time on the VOE false belief task cannot be scored as pass or fail due to the between-subject design, the total looking time at the display and at the target box provides an index of individual variability in a VOE task. To our knowledge, no study has examined inter-task relations involving the VOE false belief tasks in infancy. One would expect a strong association between intention and false belief performance as intention understanding involves understanding motivational states, which are known to precede the understanding of epistemic states in older children (Wellman, 2010). As expected, both variables measuring looking time at the unexpected action in the false belief task were strongly correlated with infants' ability to predict the unfulfilled intention of the experimenter. A challenge for proponents of the rich interpretation of infants' behaviours in the nonverbal ToM tasks will be to demonstrate the type of inter-task coherence that several studies have reported between forms of the false belief tasks or between false belief and other theoretically related acquisitions in older children (Gopnik & Astington, 1988; Moore, Pure, & Furrow, 1990).

Turning to the association observed between performance on the false belief task and the executive functioning task, infants' total looking time at the display in the false belief task (Full Box condition) was strongly correlated to their scores on the detour retrieval task. These results were unexpected, seeing as the spontaneous-response false belief task has been described to test infants' understanding of false beliefs without the additional cognitive demands required in elicited-response false belief tasks. The detour retrieval task measures children's ability to inhibit a prepotent response in order to carry out a desired response. That is, infants had to inhibit their response to reach for the toy through the transparent window, and instead turn the knob on the side of the box. Results from this analysis demonstrate that children with greater inhibitory control in the detour retrieval task also looked longer at the display in the false belief task, suggesting that executive functioning abilities may play a role in infants' performance on this task. The fact that infants' total looking time at the display in the Empty box condition was not significantly correlated with the detour retrieval task suggests that this finding cannot simply be explained by better attentiveness during the task. If longer looking times were due to attentiveness then one would expect the detour retrieval task to be correlated with total looking time in the Empty box condition as well. Moreover, the significant negative correlation between infants' total looking time at the display in the false belief task (Full Box condition) and the number of training trials administered supports the role of executive functioning in the false belief task. That is, the training task can be used as a measure of infants' executive functioning abilities as the task requires infants to inhibit their response (based on a pre-existing rule that objects are in the last place they were seen) to successfully retrieve the toy. The link observed between infants' total looking time at the target box in the empty box condition and their score on the detour retrieval task suggests that infants with better inhibitory control abilities were better able to attend to where the experimenter was searching in the false belief task (empty box) and inhibit any tendency to look to where the toy was actually hidden (full box). Unfortunately, the current study did not have a measure controlling for general cognitive abilities, therefore it is possible that the observed correlation are due to infants' general intelligence.

Although results from the current study do not completely clarify whether or not infants use behavioural rules in the false belief task based on the VOE paradigm, it is the first study to directly address this issue. Many questions remain about the nature of infants' behaviours in belief-inducing situations. One question concerns the apparent inconsistency in the putative precocity of false belief reasoning in relation to other theory of mind abilities in infancy. For example, how could the "late" emergence of intention and desire understanding during the second year be reconciled with false belief understanding in 13- and even 7-month-old infants? (Kovacs et al., 2010; Surian et al., 2007). It is well established that motivational mental states are understood before epistemic states in theory of mind development (Wellman, 2010). Furthermore, if true belief is the default assumption that infants must overcome in order to reason about false belief, one would assume that infants should first attribute true belief to others before they attribute false beliefs. Surprisingly, no such developmental sequence has been reported in all the studies published on implicit false belief in infancy, with infants as young as 7 months equally proficient at both types of reasoning. Until these issues are investigated, the idea that mental state concepts matures during the second year of life remains an intriguing belief.

References

Baillargeon, R., Scott, R. M., & He, Z. (2010). False-belief understanding in infants. *Trends in Cognitive Sciences*, *14*, 110-118. doi:10.1016/j.tics.2009.12.006

Behne, T., Carpenter, M., Call, J., & Tomasello, M. (2005). Unwilling versus unable: Infants' understanding of intentional action. *Developmental Psychology*, *41*, 328-337. doi: 10.1037/0012-1649.41.2.328

Bellagamba, F., Camaioni, L., & Colonnesi, C. (2006). Change in children's understanding of others' intentional actions. *Developmental Science*, *9*, 182-188. doi: 10.1111/j.1467-7687.2006.00478.x

Bellagamba, F., & Tomasello, M. (1999). Re-enacting intended acts: Comparing 12- and 18-month-olds. *Infant Behavior and Development*, *22*, 277-282. doi: 10.1016/S0163-6383(99)00002-8

Berthiaume, V. G., Onishi, K. H., & Shultz, T. R. (2008). *A computational developmental model of the implicit false belief task*. In B. C. Love, K. McRae, & V. M. Sloutsky (Eds.), Proceedings of the 30th Annual Conference of the Cognitive Science Society (pp. 825-830). Austin, Tx: Cognitive Science Society.

Bloom, P., & German, T. P. (2000). Two reasons to abandon the false belief task as a test of theory of mind. *Cognition, 77,* B25-B31. doi: 10.1016/S0010-0277(00)00096-2

Buttelmann, D., Carpenter, M**.**, & Tomasello, M. (2009). Eighteen-month-old infants show false belief understanding in an active helping paradigm. *Cognition, 112,* 337-342. doi:10.1016/j.cognition.2009.05.006

Carlson, S. M., Mandell, D. J., & Williams, L. (2004). Executive function and theory of mind: Stability and prediction from ages 2 to 3. *Developmental Psychology, 40,* 1105-1122. doi: 10.1037/0012-1649.40.6.1105

Carlson, S. M., Molson, L. J., & Hix, H. R. (1998). The role of inhibitory processes in young children's difficulties with deception and false belief. *Child Development, 69,* 672-691. doi: 10.2307/1132197

Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development, 72,* 1032-1053. doi: 10.1111/1467-8624.00333

Carpenter, M., Akhtar, N., & Tomasello, M. (1998). Fourteen- through 18-month-old infants differentially imitate intentional and accidental actions. *Infant Behavior and Development*, *21*, 315-330. doi: 10.1016/S0163-6383(98)90009-1

Clements, W. A., & Perner, J. (1994). Implicit understanding of belief. *Cognitive Development, 9,* 377-395. doi: 10.1016/0885-2014(94)90012-4

Garnham, W. A., & Ruffman, T. (2001). Doesn't see, doesn't know: is anticipatory looking really related to understanding of belief? *Developmental Science*, *4*, 94-100. doi: 10.1111/1467-7687.00153

Gopnik, A., & Astington, J. W. (1988). Children's understanding of representational change and its relation to the understanding of false belief and the appearance-reality distinction. *Child Development, 59*, 26-37. doi: 10.2307/1130386

Haith, M. M. (1998). Who put the cog in infant cognition? Is rich interpretation too costly? *Infant Behavior and Development*, *21*, 167-179. doi: 10.1016/S0163-6383(98)90001-7

Hughes, C. (1996). Control of action and thought: Normal development and dysfunction in autism: A research note. *Journal of Child Psychology and Psychiatry, 37,* 229-236. doi: 10.1111/j.1469-7610.1996.tb01396.x

Hughes, C., & Ensor, R. (2007). Executive function and theory of mind: Predictive relations from ages 2 to 4. *Developmental Psychology, 43*, 1447-1459. doi: 10.1037/0012-1649.43.6.1447

Kovacs, A. M., Teglas, E., & Endress, A. D. (2010). The social sense: Susceptibility to others` beliefs in human infants and adults. *Science, 330,* 1830-1834. doi: 10.1126/science.1190792

McGuigan, N., & Nunez, M. (2006). Executive functioning by 18-24-month-old children: Effects of inhibition, working memory demands and narrative in a novel detour reaching task. *Infant and Child Development, 15,* 519-542. doi: 10.1002/icd.477

Meltzoff, A. N. (1995). Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. *Developmental Psychology, 31,* 838-850. doi: 0012-1649/95/S3.00

Moore, C., Pure, K., & Furrow, D. (1990). Children's understanding of the modal expression of speaker certainty and uncertainty and its relation to the development of a representational theory of mind. *Child Development, 61,* 722-730. doi: 10.2307/1130957

Morgan, C. L. (1903). *Introduction to comparative psychology* (2nd edition). London: Walter Scott.

Neumann, A., Thoermer, C., & Sodian, B. (2008). *False belief understanding in 18-month-olds' anticipatory looking behavior: An eye-tracking study*. Paper presented at the XXIX International Congress of Psychology, Berlin, Germany, 20-25 July 2008

Olineck, K. M., & Poulin-Dubois, D. (2009). Infants' understanding of intention from 10 to 14 months: Interrelations among violation of expectancy and imitation tasks. *Infant Behaviour and Development, 32,* 404-415. doi: 10.1016/j.infbeh.2009.06.005

Onishi, K. H., & Baillargeon, R. (2005). Do 15-month-old infants understand false beliefs? *Science, 308,* 255-258. doi: 10.1126/science.1107621

Perner, J. (2010). Who took the cog out of cognitive science? Mentalism in an era of anti-cognitivism. In P.A. Frensch & R. Schwarzer (Eds.), Perception, attention, and action: International perspectives on psychological science (Volume 1) (pp. 241-261). Psychology Press.

Perner, J., Leekam, S. R., & Wimmer, H. (1987). Three-year-olds' difficulty with false belief: the case for a conceptual deficit. *British Journal of Developmental Psychology*, *5*, 125-137. Retrieved from http://www.wiley.com/bw/journal

Perner, J., & Ruffman, T. (2005). Infants' insight into the mind: How deep? *Science, 308,* 214-216. doi: 10.1126/science.1111656

Poulin-Dubois, D., Brooker, I., & Chow, V. (2009). The developmental origins of naïve psychology in infancy. In P. J. Bauer (Ed.), *Advances in Child Development and Behavior: Vol. 37.* (pp.57-106). San Diego, CA: Elsevier Academic Press.

Ruffman, T., & Perner, J. (2005). Do infants really understand false belief? *Trends in Cognitive Sciences, 9,* 462-463. doi:10.1016/j.tics.2005.08.001

Scott, R. M., & Baillargeon, R. (2009). Which penguin is this? Attributing false beliefs about object identity at 18 months. *Child Development, 80,* 1172-1196. doi: 10.1111/j.1467-8624.2009.01324.x

Scott, R. M., & Baillargeon, R., Song, H., & Leslie, A. M. (2010). Attributing false beliefs about non-obvious properties at 18 months. *Cognitive Psychology, 61,* 366-395. doi: 10.1016/j.cogpsych.2010.09.001

Sirois, S., & Jackson, I. (2007). Social cognition in infancy: A critical review of research on higher-order abilities. *European Journal of Developmental Psychology, 4*, 46–64. doi: 10.1080/17405620601047053

Song, H. J., Onishi, K. H., Baillargeon, R., & Fisher, C. (2008). Can an agent's false belief be corrected by an appropriate communication? Psychological reasoning in 18-month-old infants. *Cognition, 109,* 295-315. doi: 10.1016/j.cognition.2008.08.008

Southgate, V., Senju, A., & Csibra, G. (2007). Action anticipation through attribution of false belief by 2-year-olds. *Psychological Science, 18,* 587-592. doi: 10.1111/j.1467-9280.2007.01944.x

Stevens, J. R. (2010). The challenges of understanding animal minds. *Frontiers in Psychology, 1,* 1-3. doi: 10.3389/fpsyg.2010.00203

Surian, L., Calder, S., Sperber, D. (2007). Attribution of beliefs by 13-month-old infants. *Psychological Science*, *18*, 580-586. . doi: 10.1111/j.1467-9280.2007.01943.x

Träuble, B., Marinović, V., & Pauen, S. (2010). Early Theory of mind competencies: Do infants understand others' beliefs? *Infancy, 15,* 434-444. doi: 10.1111/j.1532-7078.2009.00025.x

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development, 72,* 655-684. doi: 10.1037/0012-1649.44.2.618

Wellman, H. M. (2010). Developing a theory of mind. In U., Goswami (Ed.), *The Wiley-Blackwell Handbook of Childhood Cognitive Development* (2nd ed., pp 258-284). Malden, MA: Blackwell Publishing.

Zelazo, P. D., Craik, F. I. M., Booth, L. (2004). Executive function across the lifespan. *Acta Psychologica, 115,* 167-168. doi: 10.1016/j.actpsy.2003.12.005

Appendix A

Sample Recruitment Letter

Dear Parents,

The Cognitive Development Laboratory of Concordia University is currently interested in children's early development of trust, and how this influences their willingness to learn, help and cooperate with another person. We are truly grateful for your previous participation in one of our infancy studies and would like to invite you to participate to this new research project. This research is funded by the Social Sciences and Humanities Research Council of Canada.

The present investigation involves a few short games. In a succession of games, your child will observe a female experimenter produce a series of demonstrations, after which he or she will get a chance to be involved. These tasks will vary, depending on the experiment, but may entail: learning to find the location of a hidden toy, observing the experimenter as she labels familiar objects either correctly or incorrectly, as well as using or misusing their proper function; word learning; imitating a series of novel actions; helping the experimenter to complete an action; observing the experimenter interact with a toy inside a puppet-theater; and learning to perform an action in order to retrieve a toy from inside a little house. During all tasks, your child will either be sitting in a child seat and you will be seated directly behind, or he/she will be required to be standing and/or assisting the experimenter by engaging with certain props (e.g., a small cabinet). The whole session should last approximately 45 minutes. We will videotape your child's responses and all tapes will be treated in the strictest of confidentiality.

Overall, your participation will involve approximately one 45-minute visit to our laboratory at the Loyola Campus of Concordia University, located at 7141 Sherbrooke Street West, in Notre-Dame-de-Grace. Appointments can be scheduled at a time which is convenient for you and your child, including weekends. Free parking is available on the campus. Upon completion of the study, a Certificate of Merit for Contribution to Science will be given to your child, and **you will be offered a financial compensation of 20$ for participating.** A summary of the results of our study will be mailed to you once it is completed.

For the purposes of this study, we are looking for infants who are 16-20 months of age, who hear English or French spoken in the home, and who do not have any visual or hearing difficulties. If you are interested in having your child participate in this study, or would like any further information, please contact Alexandra Polonia at (514) 848-2424 ext. 2279, or Dr. Diane Poulin-Dubois at (514) 848-2424 ext. 2219. We will try to contact you by telephone a few days after you have received this letter.

We are looking forward to speaking with you in the near future.

Sincerely yours,

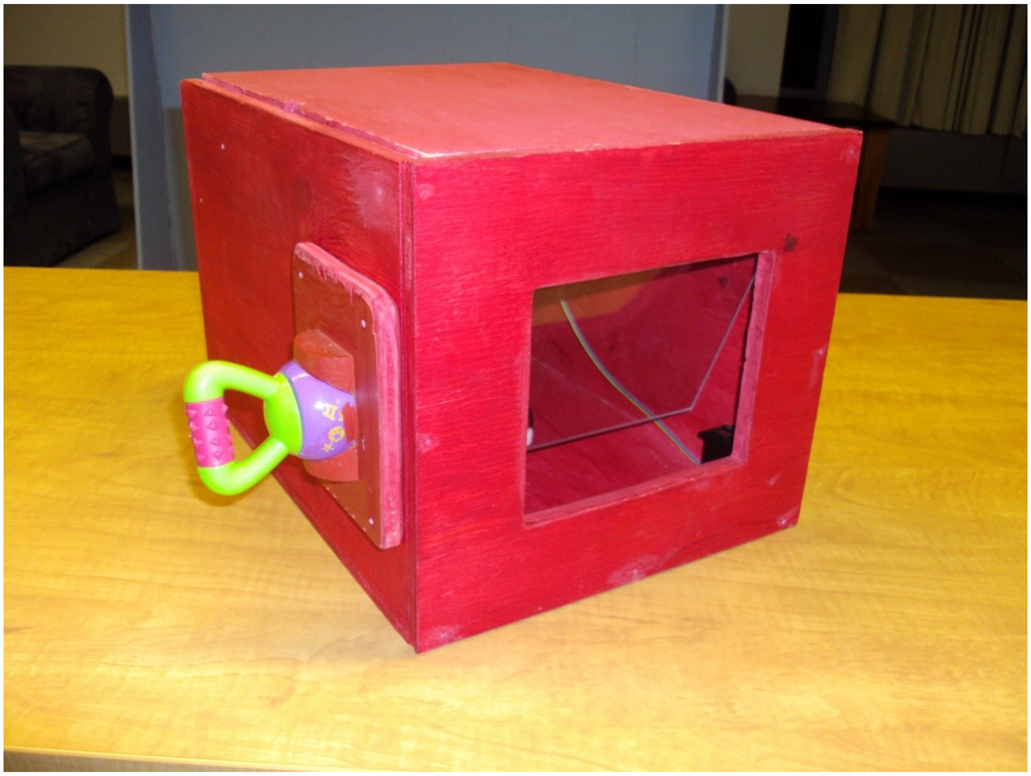
Diane Poulin-Dubois, Ph.D. Professor Psychology Department	Alexandra Polonia, B.A. Laboratory Coordinator Psychology Department

Appendix B

False Belief Task Apparatus and Stimuli

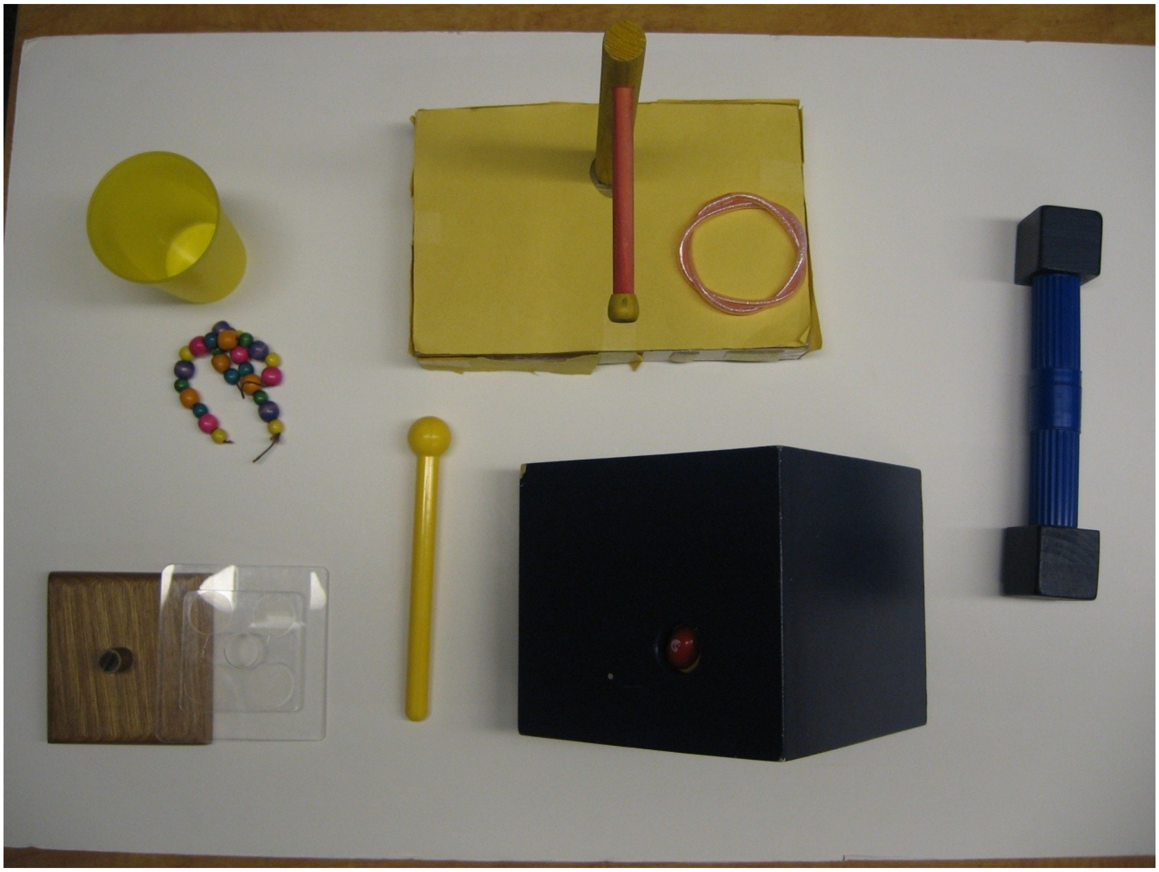
Appendix C

Detour Retrieval Task Apparatus



Appendix D

Behavioural Re-enactment Task Stimuli



Appendix E

Sample Parental Consent Form

Parental Consent Form

This is to state that I agree to allow my child to participate in a research project being conducted by Dr. Diane Poulin-Dubois, in collaboration with Jessica Yott of Concordia University.

A. PURPOSE

I have been informed that the purpose of the research is to examine infants' understanding of other people's mental states.

B. PROCEDURES

The present investigation involves 5 short games. In the first game, your child will observe a female experimenter perform an action in order to retrieve a toy from inside a red box. Following this demonstration your child will be given the opportunity to retrieve the toy by him- or herself. In the second game, the experimenter will be hiding a toy inside one of two containers and your child will be given the opportunity to find the toy. In a third game, your child will observe the experimenter hide a toy cup in one of two boxes and then reach for the hidden toy either in the correct location or in the incorrect location. We will record where your infant is looking in order to determine his/her expectation regarding where the experimenter will look for her toy. Next, your child will watch the experimenter perform an action, but fail to complete it. Following this demonstration, your child will be given the opportunity to complete the intended action. In the final game, the experimenter will hide toys inside one of three drawers and your child will be asked to find the toy.

During all tasks, your child will be sitting in a child seat and you will be seated directly behind. We will videotape your child's responses and all tapes will be treated in the strictest of confidentiality. That means that the researcher will not reveal your child's identity in any written or oral reports about this study. Your child will be assigned a coded number, and that number will be used on all materials collected in this study. As well, because we are only interested in comparing children's understanding as a function of age, no individual scores will be provided following participation. The entire session is expected to last approximately 45 minutes.

C. RISKS AND BENEFITS

Your child will be given a certificate of merit at the end of the session as a thank-you for his/her participation. Also, you will be offered 20$ for your participation.

There is one condition which may result in the researchers being required to break the confidentiality of your child's participation. There are no procedures in this investigation that inquire about child maltreatment directly. However, by the laws of Québec and Canada, if the researchers discover information that indicates the possibility of child maltreatment, or that your child is at risk for imminent harm, they are required to disclose this information to the appropriate agencies. If this concern emerges, the lead researcher, Dr. Diane Poulin-Dubois, will discuss the reasons for this concern with you and will advise you of what steps will have to be taken.

D. CONDITIONS OF PARTICIPATION

- I understand that I am free to withdraw my consent and discontinue my participation at any time without negative consequences, and that the experimenter will gladly answer any questions that might arise during the course of the research.
- I understand that my participation in this study is confidential (i.e. the researchers will know, but will not disclose my identity).
- I understand that the data from this study may be published, though no individual scores will be reported.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOUNTARILY AGREE TO HAVE MY CHILD PARTICIPATE IN THIS STUDY.

MY CHILD'S NAME (please print) ______________________________________

MY NAME (please print) ____

SIGNATURE ____________________________ DATE ____________________

WITNESSED BY _________________________ DATE ____________________

I would be interested in participating in other studies with my child in the future (yes/ no): _____

If at any time you have questions about your rights as a research participant, you are free to contact Adela Reid, Research Ethics and Compliance Officer, Concordia University, at (514) 848-2424 ext 7481 or by email at areid@alcor.concordia.ca

_______________________	_______________________
Diane Poulin-Dubois, Ph.D.	Jessica Yott, B.A
Professor	M.A Candidate
Department of Psychology	Department of Psychology
848-2424 ext. 2219	848-2424 ext. 2279
diane.poulindubois@concordia.ca	j_yott@live.concordia.ca

Participant # _____________ Researcher: ___________________

Appendix F

Demographics Questionnaire

Participant Information

Infant's first name: ________________________ Date of Birth: ____________

Infant's last name: _____________________________ Gender: ___________

Language(s) spoken at home (and other places):________________

Mother's first name: ____________________ Father's first name: _______________

Mother's maiden name: __________________ Father's last name: ________________

Address: _____________________________ Telephone #:________________home

City: _________________________________ ____________work mom

Postal Code:___________________________ _______________work dad

E-mail: _______________________________

Mother's occupation:______________________ Father's occupation:________________

Mother's education (highest level attained):_____________________________________

Father's education (highest level attained):_____________________________________

Mother's marital status:___________________ Father's marital status:___________

***P**lease answer the following general information questions about your child:*

Birth weight:_____________ Length of pregnancy:_______weeks

Birth order:______________(e.g., 1 = 1st child)

Number of children in family:__________________

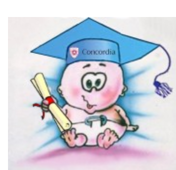
Were there any complications during the pregnancy?______________________________

Has your child had any major medical problems?_________________________________

Does your child have any hearing or vision problems?_____________________________

** Have you ever been contacted by another university to participate in one of their studies? (Yes/No): ____________________________________

** If you answered yes, please name the university: ________________________



Appendix G

Training Task Blank Coding Sheet

TRAINING (18-Months)

Subject Number:_________ Sex: F M Tested by:_____________ Order:_________ Birth date:___________

Test date:____________ Coder:_____________ Today's Date___________ Lap Baby: Y N

Parental Interference:__________________________________ Condition: Experimental Control

Comments:____

____

Warm-up Trial

Removed Lid	Examined Contents?
YES NO	YES NO

Test Trials (Max 4)

Trial	First Container Examined	How?	Examined Contents alone?	Latency to Examine?	Second Container Examined	Examined Contents alone?	How?	Latency to Examine?	Pass or Fail?
1			YES NO			YES NO			P F
2			YES NO			YES NO			P F
3			YES NO			YES NO			P F
4			YES NO			YES NO			P F

Teaching Trail

First Container Examined	How?	Examined Contents alone?	Latency to Examine?	Second Container Examined	Examined Contents alone?	How?	Latency to Examine?	Pass or Fail?
		YES NO			YES NO			P F

Test Trials (Max 4)

Trial	First Container Examined	How?	Examined Contents alone?	Latency to Examine?	Second Container Examined	Examined Contents alone?	How?	Latency to Examine?	Pass or Fail?
1			YES NO			YES NO			P F
2			YES NO			YES NO			P F
3			YES NO			YES NO			P F
4			YES NO			YES NO			P F

Were any extra trials administered? YES NO

First Container Examined	How?	Examined Contents alone?	Latency to Examine?	Second Container Examined	Examined Contents alone?	How?	Latency to Examine?	Pass or Fail?
		YES NO			YES NO			P F

Total Number of trials administered ______________________

Appendix H

False Belief Task Blank Coding Sheet

False Belief Task (18 M)

Subject Number: __________ Coded by: _______________
Order: __________________ Date coded: _____________
Condition: _______________

Comments:

****NOTE: coding should be done from the experimenter's perspective

Full Box	Empty Box	Experimenter	Outside Display	Total Time	What side was target toy on?

Proportion (%) for target location
Proportion (%) for nontarget location

Appendix I

Detour Retrieval Task Blank Coding Sheet

Detour Retrieval Task (18 – Months)

Subject Number:________ Sex: F M Tested by:____________ Order:________ Birth date:________

Test date:___________ Coder:____________ Today's Date__________ Lap Baby: Y N

Parental Interference:_______________________________ Condition: Experimental Control

Comments:____

____

Trial	First Attempt	Latency	Second Attempt	Latency	Successful
1	W K		W K		YES NO
2	W K		W K		YES NO
3	W K		W K		YES NO
4	W K		W K		YES NO

W = Window K = Knob

Score out of 4 ________

Appendix J

Behavioural Re-enactment Task Blank Coding Sheet

Behavioural Re-enactment Task (18 – Months)

Subject Number:________ Sex: F M Tested by:____________ Order:________ Birth date:__________

Test date:___________ Coder:____________ Today's Date__________ Lap Baby: Y N

Parental Interference:________________________________ Condition: Experimental Control

Comments:____
____

Order	Task	Completed Action	Latency (from when child touches toy)
	Dumbell	Yes No	
	Box and Button	Yes No	
	Bracelet and Prong	Yes No	
	Cup and Beads	Yes No	
	Dowel and Plastic Square	Yes No	

Score out of 5 ______________